

Socioeconomic and Ecological Monitoring Toolkit: Huraa Mangrove Nature Reserve

Prepared for the Environmental Research Centre, Ministry of Environment, Energy and Water by:
IUCN Ecosystems and Livelihoods Group, Asia



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1. Introduction

1.1 What is monitoring?

Monitoring is basically the repeated observation of a system in order to detect signs of change. Monitoring can be used to quantify change, identify the causes of change and determine acceptable levels of change.

In this toolkit, we focus on both human (socioeconomic) and biophysical (ecological) aspects of monitoring. Socioeconomic monitoring normally focuses on people's knowledge and attitude towards an ecosystem as well as their natural resource use and dependence. Ecological monitoring on the other hand will generally focus on a specific species or ecosystem, using supporting information on environmental conditions and associated organisms. Together, they provide us with a picture of the human and environmental changes which take place over time in a particular place, how they are interlinked and how we might improve management in order to address socioeconomic and ecological changes and threats.

1.2 Why are we carrying out monitoring on Huraa?

Huraa Mangrove Nature Reserve (HMNR) has been designated a Protected Area, in recognition of the fact that it is an important natural mangrove habitat which contains species of particular conservation significance to the Maldives and the rest of the world. A human community also live on Huraa Island who is itself affected by the existence of the Nature Reserve, and whose day-to-day life and activities in turn impact on the mangrove ecosystem.

It is important to be able to track the changes that are occurring as a result of the Nature Reserve, as they impact both on the natural environment and on the human population. Monitoring of HMNR therefore looks at both (a) future changes in the mangrove ecosystem and (b) social and economic changes related to the mangrove ecosystem. It provides vital information to make improved management decisions about ways to better conserve HMNR in the future, and to ensure that its existence continues to benefit the island community to the greatest extent possible.

1.3 What is the purpose of this toolkit?

There is a need for the monitoring plan for HMNR to be implementable, relevant and useful in the light of available resources, local ecological and socioeconomic conditions and the management goals of the Nature Reserve.

Properly thought-through, intensive monitoring can be expensive, time consuming and often requires the personnel involved to have an advanced level of expertise in the systems being monitored. Traditionally, socioeconomic and ecological monitoring have been carried out in isolation from each other, by different teams and using non-complementary monitoring protocols. In contrast the monitoring plan for HMNR has been designed to be practical to carry out and to integrate between natural science and social science approaches, methods and information.

This toolkit brings together a simple range of methodologies to carry out regular, joint socioeconomic and ecological monitoring in HMNR. It outlines the techniques that can be used to collect data and provides a framework for monitoring and analysis that can be used by individuals with no prior training in the field of socioeconomic and ecological monitoring.

2. Overview of the monitoring process

2.1 Why do we monitor?

The monitoring of mangrove ecosystems as well as people's knowledge, attitude and practices is important because it allows us to improve management practices in response to any detected changes in either socioeconomic or biophysical conditions and status:

- Through socioeconomic monitoring we can better understand what human induced factors are affecting the mangrove, whether people are benefiting from the current levels of management and how they perceive HMNR. In response to this knowledge we can adjust management practices to better achieve socioeconomic management goals.
- Through ecological monitoring we are able to form a picture of how the mangrove ecosystem that HMNR aims to conserve is doing – whether it is stable, improving or declining. In response to this knowledge we can adjust conservation practices for HMNR to better achieve its biophysical management goals.

2.2 What are the key components of monitoring?

In order to carry out monitoring, we first need to establish a baseline. The baseline is the situation, or point in time, from which we are measuring change. It provides a snapshot of the situation at the start of the monitoring process. In HMNR, we want to know how people currently live, survive, interact with the mangroves, perceive conservation, and benefit (or not) from the protected area. We also want to document what the ecosystem looks like, which species are present and in what numbers. The subsequent monitoring that is carried out shows how socioeconomic or ecological conditions and status have changed over time relative to this baseline situation – whether things have stayed the same, improved or got worse.

At the same time, it is necessary to decide on which indicators will be used to monitor change in the future. Indicators are particular objects, conditions, or characteristics which show socioeconomic or ecological health or status. As we will examine below, these indicators need to represent the goals, threats, impacts and locally-important conditions that pertain to HMNR. The subsequent monitoring that is carried out tracks the changes in these indicators, in order to draw more general conclusions about socioeconomic and ecological trends over time.

After the baseline situation is ascertained, and indicators chosen, longer-term monitoring can be carried out. Monitoring is the repeated observation of HMNR in order to detect signs of change in both ecological and socioeconomic status and health.

Maintaining a knowledge-practice feedback loop in order to ensure adaptive management which responds to the changes noted is a key aspect of monitoring. Without monitoring ecological and socioeconomic changes over time, especially those which result from a particular management action being carried out in HMNR, or have impacts on one of

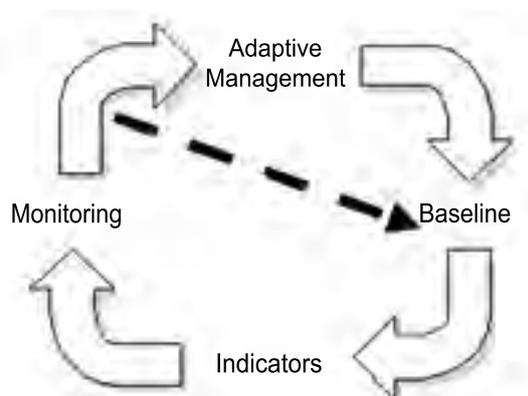


Figure 1: Adaptive management loop showing the relationship between the different components of monitoring and how they relate to each other and the adaptive management process.

HMNR's particular management goals, the Ministry will not be in a position to assess if their decisions are effective and have had the intended impacts and/or if the goals set out in their management plan are being reached. Evaluating the recorded changes allows us to see if new issues emerge that require the application of an adaptive and/or reactive management approach in the future in HMNR, to respond to the changing situation and conditions on Huraa and better meet conservation and sustainable development goals in the future.

2.3 Why carry out joint socioeconomic and ecological monitoring?

It is generally understood that there are two distinct types of monitoring: ecological monitoring and performance monitoring (Abbot and Guijt, 1998¹). Traditional approaches to protected area management have focused on ecological monitoring: on understanding the biological, chemical and physical issues affecting an ecosystem and implementing physical and policy level management interventions to ensure ecological management goals are satisfied. If we applied this approach to HMNR, we would then only look at factors like the area and quality of mangroves, their diversity, the presence of other plant and animal species, and perhaps also measure parameters such as water quality and evidence of resource harvesting.

In contrast, performance monitoring refers to the assessment of management effectiveness, examining the outputs of laws, policies, community initiatives, donor projects and spatial planning. Performance monitoring is thus linked inextricably to socioeconomic aspects and impacts on protected areas. For HMNR, incorporating performance aspects into our monitoring system (as the integrated monitoring framework described in this document recommends) involves considering factors such as local perceptions of the protected area, levels of benefits gained, participation in management, numbers of visitors, revenues and institutional arrangements.

It is becoming widely recognised that protected area goals have to reflect the needs and aspirations of communities that are ultimately affected by conservation activities. In order to incorporate social and economic development concerns into the management goals of protected areas, socioeconomic and 'performance' factors need to be monitored so that managers can ensure that all these goals are being met. The authorities responsible for HMNR have formulated a management approach that is based on a thorough consideration of sustainable development, as well as 'pure' conservation goals: both ecological and socioeconomic/performance aspects thus need to be monitored.

Linking ecological and socioeconomic aspects of monitoring is also necessary because sustainable, effective and equitable approaches to protected area management require a thorough understanding of the interlinkages between socioeconomic and biophysical status, influences and threats. As conservation values, threats and impacts all encompass biological, ecological, economic and livelihood aspects, so protected area management responses must simultaneously address and react to each of these factors. This means that a thorough understanding of all — and of the interlinkages and interconnectivity between them — is required. In the case of HMNR, the threats to the mangrove system arise from multiple anthropogenic forces, such as irresponsible tourism, resource over-harvesting, garbage dumping, pollution, dredging and water diversion. At the same time it is recognised that local involvement in, and benefit from, the protected area are vital if conservation is to be successful. On-the-ground management of HMNR therefore needs to consider all these aspects.

¹ Abbot J.; Guijt I. 1998. *Changing views on change: participatory approaches to monitoring and evaluation*. International Institute for Environment and Development, London, UK. SARL discussion paper no. 2

In order to integrate ecological monitoring with socioeconomic monitoring, there is thus a need to develop a holistic monitoring plan that relates the findings from one discipline to the other, and looks at how we can effectively track (and achieve) goals relating to both sound ecological management and improved community and economic development. This principle lies at the root of the monitoring plan that has been developed for HMNR and is described in this document.

2.4 How is monitoring useful for management decision-making?

However academically interesting it is to know the status, characteristics or health of a particular human population or natural ecosystem, monitoring is not usually an end in itself. It is a means to an end – better and more informed conservation and development decision-making. A key aim of carrying out monitoring is to improve management practice and to ensure that it is well-informed by, and responsive to, the situation on the ground.

In the case of HMNR, the management plan sets out a number of goals and objectives which relate to different aspects of the protected area, ranging from scientific information and research, through active management and sustainable utilisation of species and ecosystems, to plans for tourism development and local participation in park management. Monitoring can provide useful information for planning and implementing all of these management decisions, including:

- 1. To provide information for sustainable management of natural resources**
This can include the planning of sustainable fishery yields and forest product extraction rates. Monitoring can support decisions regarding the zoning of resource areas to maximise the sustainability of extraction, for example through pinpointing areas that should be used for extraction, areas that should be set aside for regeneration or areas that could be utilised for multiple uses. Monitoring allows us to determine whether specific management interventions are achieving the desired conservation goals and adapt management accordingly. Monitoring also supports our understanding of the economic value of natural resources. This is important knowledge for decision makers who need to plan the wise use of finite resources.
- 2. To determine changes and threats to ecosystems**
Monitoring can be used to support Environmental Impact Assessments and Risk Assessments, allowing us to better understand where potential changes and threats to ecosystems originate from so that we can make management decisions in order to mitigate or minimise the impact of these. It also allows us to manage invasive alien species that may threaten native species and ecosystems.
- 3. To track changes in people's knowledge, perception and use of ecosystems**
Achieving sustainable use of ecosystems and their services will often require enhancing people's understanding of the benefits and values being provided by an ecosystem and its services, as well as altering extraction practices.
- 4. To plan and implement restoration activities**
Monitoring provides us with the information that we need to develop recovery programmes for endangered species or damaged ecosystems. Monitoring is essential to guide activities relating to ecosystem rehabilitation and replanting/regeneration, and would enable to determine the outcome (success/failure) of active restoration work.
- 5. To facilitate the formulation and implementation of conservation legislation and policies based on scientific information**
The above knowledge is essential for policy makers and managers, who require science-based information in order to make the best governance and management decisions for wise and sustainable ecosystem management.

6. To develop nature-based tourism

Information generated can be used towards developing and promoting nature-based tourism. These activities can in turn generate money and resources that can be invested in future species and ecosystem management.

7. To contribute towards education and public awareness on conservation

Monitoring can contribute to educational and awareness programmes, increasing knowledge about key species or ecosystems. Monitoring can also be conducted in partnership with students and the public, to involve them in the process of management and learning.

2.5 How should we select monitoring indicators?

As explained above, indicators are particular objects, conditions, or characteristics which can be used to measure more general socioeconomic or ecological conditions. Certain principles guide the choice of which indicators are used for monitoring HMNR, and will be tracked over time.

One consideration is practicality. When a monitoring exercise has a limited time frame and funding (such as is the case for HMNR), it is impossible to document each and every relevant condition, parameter and change that takes place. For example it is just not realistic to expect to be able to monitor every plant and animal species in HMNR, or to look at every single health, income, welfare and livelihood indicator for the whole population of Huraa Island.

Furthermore, it is not necessary to track every single aspect of the local ecology and socio-economy. Rather we can identify key indicators which represent, or act as markers, for broader ecosystem and socioeconomic status and health. Tracking changes in these key indicators gives us a picture of trends and changes in the broader system. Ecological and biodiversity aspects of monitoring will take indicator taxa (groups or categories of living organisms), and socioeconomic aspects will take indicator economic and social parameters, which will be measured over time. The most important feature of an indicator is that it must very clearly reflect or 'indicate' some aspect of the status or condition of what we want to measure, whether it is the status of a particular species of mangroves, or the economic condition of the adjacent community.

A final consideration in choosing indicators is that they should be easy to measure, observe and track over time. There is no point in identifying a series of ecological and socioeconomic parameters which require such highly detailed research, expensive equipment or complicated analysis to track that they are beyond the means and capacities of the agency or group who is charged with monitoring them.

In summary, monitoring indicators should be:

- Measurable – Able to be recorded and analysed in quantitative or qualitative terms
- Precise – Defined the same way by all people
- Consistent – Not changing over time so that it is always measuring the same thing
- Sensitive – Changing proportionately in response to actual changes in the attribute or item being measured
- Simple – Simple indicators are generally preferred to complex ones
- Distributed over a broad geographical area, or otherwise widely applicable
- Capable of providing a continuous assessment over a wide range of stress

- Relatively independent of sample size
- Easy and cost-effective to measure, collect, and/or calculate
- Able to differentiate between natural cycles or trends and those induced by anthropogenic stress
- Relevant to ecologically significant phenomena

3. Requirements for carrying out the HMNR monitoring plan

The following monitoring plan is suggested for the regular, long term monitoring of HMNR. The data collected should be compared against the baseline data that was collected in May 2007 (presented in Annex 3). As with any monitoring system, it is recommended that this plan be reviewed every 2-3 years, so as to determine whether the chosen indicators are still relevant in the light of both Huraa Island's local conditions and HMNR's management goals, and in order to periodically update the baseline.

3.1 Monitoring goals

In line with the management goals and management plan prepared for HMNR, the monitoring goals are:

- To monitor potential physical changes that may affect HMNR so as to mitigate any negative threats to the mangrove ecosystem
- To monitor the economic benefits derived from HMNR in order to maximise the economic value of HMNR to the local community
- To monitor changes in the community's perceptions and attitudes towards HMNR in order to improve knowledge of the goods and services provided by mangroves and in order to create community support for protected area management

3.2 Duration and personnel

It is estimated that the full monitoring plan presented in this document can be completed within a period of 2-3 days by a field team of about 5 people. As an integrated approach to monitoring is being followed, it is important that the monitoring team themselves are also integrated. Socioeconomic and ecological monitoring should be carried out at the same time, by the same team.

It is suggested that at least half the members of the field team have prior experience or training in general socioeconomic and/or ecological monitoring techniques to assure accurate and reliable data collection. It is also suggested that the team should include members of the local community, so as to ensure their active support and involvement in conservation processes, incorporate their knowledge and perceptions, and build their capacity to take over monitoring activities in the long term.

3.3 Frequency of monitoring

The monitoring plan should be implemented regularly. It is important to ensure that the data collected is representative of, and reflects, any regular fluctuations and changes in the local environment. This will mean that comparisons can be easily made over time, and accurate conclusions can be drawn as to whether changes are affecting the local community and HMNR itself. For Huraa Island, the main consideration is to ensure that monitoring information includes data collected under both dry and wet season conditions.

It is suggested that monitoring be carried out at the following intervals:

1. Socioeconomic monitoring: this should be carried out annually, with the exception of monitoring students' and tourists' knowledge and understanding which should be carried out throughout the year.
2. Ecological monitoring: this should be carried out twice a year – once during the monsoon season and once during the non-monsoon/dry season.

3.4 Equipment

General equipment required for all monitoring:

- Pens/pencils
- Note paper
- Survey sheets
- Clip boards
- Global Positioning System (GPS)
- Digital Camera

Specific equipment required for ecological monitoring:

- Cast Nets x 2
- 1 litre buckets x 15
- Measuring tape x 2
- Nylon rope
- Binoculars
- Plastic containers of various sizes for specimen collection x10
- Identification guides for:
 - Birds
 - Crabs
 - Fish
 - True mangrove species
 - Mangrove associate plant species
 - Mammals
 - Other invertebrates (e.g. molluscs, butterflies etc.)

3.5 Notes on good field practice

When filling out both ecological and socioeconomic survey data sheets, the following information should always be recorded:

- Name(s) of data recorders
- Date
- Time
- Location/GPS coordinates

These details are important, for if there are any doubts over the recorded data the original recorder can be consulted. The date, time and location details are essential for comparing data over time.

One person in the field team should be made responsible for collating the field data sheets. On each day of the monitoring exercise, the completed sheets should be reviewed at the end of the day in order to highlight any inconsistencies/errors in data collection so that these issues can be resolved with the assistance of the data recorder concerned (e.g. any missing data can be collected during the next day's field work). Data sheets should be carefully stored and kept for reference even after data has been copied. All data should be inputted by computer on the day that the data is collected. If this is impractical due to lack of computer facilities, the data should be inputted within 2 weeks of returning from the field.

4. Socioeconomic monitoring indicators and techniques

4.1 Defining socioeconomic indicators

The baseline assessment carried out in Huraa Island identified three main areas of interaction between human communities (both island residents and visitors) and HMNR. These are:

1. Knowledge/understanding
2. Attitude/perception
3. Practice/use.

Each of these three main areas is elaborated below in terms of known baseline and identified indicators for future monitoring of changes taking place in each. A suggested methodology for measuring these indicators is given in section 4.4, and data collection sheets are provided in Annex 1.

Table 1: Overview of socioeconomic monitoring indicators and techniques

Indicator	Technique
Indicators to assess knowledge and understanding	
Knowledge of local names of mangrove and related species and scientific names of mangroves and related species	Focus group discussions, Key informant interviews
Understanding of provisioning, supporting, regulating and cultural services provided by mangroves	
Attendance of meetings, classes, seminars and other interactions related to conservation and mangroves	
Knowledge of the existence and purpose of the gene bank	
Indicators to assess attitude and perception	
Perception of mangrove condition, basis for those perceptions	Focus group discussions, Key informant interviews
Perception of the nature and level of current threats to the mangroves	Focus group discussions
Positive or negative attitude to the existence of the protected area and the way in which it is managed	Focus group discussions, Key informant interviews
Perceptions of the types of material and indirect benefits gained from HMNR	
Perceptions of the types of material and indirect costs incurred from HMNR	
Opinions on roles and responsibilities in conservation and management of HMNR	
Perception of conflict between stakeholders in relation to HMNR	
Feeling of local 'ownership' of HMNR	
Perception as to whether the protected area is still valid and justified	
Indicators to assess practice and use	
Types and levels of extractive mangrove use taking place	Focus group discussions
Student numbers visiting HMNR	Secondary data
Tourist numbers visiting HMNR	
HMNR revenues	
HMNR staffing and annual budget	
Types and levels of earnings from HMNR-related activities for different groups shops, restaurants, handicrafts, guides, etc	Focus group discussions
Number of people benefiting from HMNR income	
Relative importance of HMNR-related income in household and village economy	

4.2 Indicators to assess knowledge/understanding

In the context of HMNR, 'knowledge and understanding' is defined as what Huraa Island's inhabitants, tourists and students believe and comprehend about the mangrove ecosystem, based on scientific research, observations, experiences, belief or perceptions of cause and effect.

The following observations were made in the baseline assessment:

- People living on Huraa Island had a good knowledge and understanding of the goods and services being provided by mangroves;
- It was not however clear to what extent students (either from Huraa Island or those who may be likely to visit the mangrove in future) have a good knowledge and understanding of the mangrove ecosystem; and
- There is a potential for tourist interest in HMNR, especially from the nearby resort island, but it is not clear how much revenue this would generate for the community.

The monitoring plan aims to see whether community members', students' and tourists' knowledge and understanding of the mangroves will change over time, as a result of the presence of HMNR as well as due to the various activities which have been initiated (such as education and awareness-raising, information materials, education centre, gene bank, tourism activities).

The extent of stakeholders' knowledge and understanding of mangrove resources can be used by HMNR authorities to make management decisions on what awareness raising and education activities are required.

Whereas it has been suggested that other aspects of socioeconomic monitoring take place once a year, monitoring of students' and tourists' knowledge needs to take place on a continuous basis. This is because these groups are not permanently resident on the island, and come on short visits spread across the year. It is suggested that a short questionnaire should be administered to each group of students or tourists who visit HMNR (teachers can assist students to fill these in), and then handed over to the Island Authorities and collected by the monitoring team when they make their twice-yearly visits. However, the monitoring team should not feel limited by this approach, and the use of more interactive methods (e.g. through the development of a quiz on HMNR and mangroves) could also be developed as part of the monitoring strategy in future.

Four indicators related to knowledge and understanding have been defined for the monitoring plan, and are outlined in Table 2 below. They are reflected in the socioeconomic data sheets presented as Annex 1 of this document.

Table 2: Suggested indicators related to knowledge/understanding

Indicator	Methodology	Why this indicator?
Knowledge of local names of mangrove and related species and scientific names of mangroves and related species	Focus group discussions, Key informant interviews	Any increases in the level of knowledge exhibited by the local community, students or tourists are indicative that education and awareness activities are having the desired outcome. If knowledge is decreasing it is an indication that communication strategies are not working and need to be changed.
Understanding of provisioning, supporting, regulating and cultural services provided by mangroves		
Attendance of meetings, classes, seminars and other interactions related to conservation and mangroves		
Knowledge of the existence and purpose of the gene bank		

4.3 Indicators to assess attitude/perception

In the context of HMNR, 'attitude and perceptions' is examined in relation to the inhabitants of Huraa Island, and defined as their positive or negative feelings towards sustainable mangrove management and ecology, cultural and religious beliefs and interest/willingness to support HMNR.

The following observations were made in the baseline assessment:

- People in Huraa Island were clear that the mangrove has been declared a protected area, but were not clear about who owns and manages it;
- People were generally interested in supporting the development of a protected area but expected some economic benefits from the protected area; and
- Developing the mangrove area for tourism and education purposes was a popular land use option favoured by the local community.

The monitoring plan aims to see whether people's understanding of protected area ownership and management issues improve over time, and also to determine whether support for tourism and education activities in HMNR increases or decreases over time relative to other land and resource use options.

The nature of stakeholders' attitude and perceptions of the protected area can be used by HMNR authorities to make management decisions on strategies for awareness raising, outreach, community participation and benefit-sharing which will respond to local people's beliefs and perceptions of the protected area.

It should be noted that stakeholder perceptions, opinions and attitudes are all very difficult to assess, because they are highly variable between individuals and at different times, and people are not always willing to state their true concerns or thoughts.

Nine indicators related to attitude and perception have been defined for the monitoring plan, and are outlined in Table 3 below. They are reflected in the socioeconomic data sheets presented as Annex 1 of this document.

Table 3: Suggested indicators related to questions of attitude/perception

Indicator	Methodology	Why this indicator?
Perception of mangrove condition, basis for those perceptions	Focus group discussions, Key informant interviews	If the community is unaware of the condition of and threats to the mangrove, and ignorant of management arrangements there will be a correspondingly poor level of understanding of the need for the special management of mangrove areas, and poor support for HMNR. These indicators show how well management is communicating with the local community, and communication strategies should be developed and modified in response to any changes in these indicators. This is important for creating long term support and understanding of HMNR.
Perception of the nature and level of current threats to the mangroves	Focus group discussions	
Positive or negative attitude to the existence of the protected area and the way in which it is managed	Focus group discussions, Key informant interviews	
Perceptions of the types of material and indirect benefits gained from HMNR		
Perceptions of the types of material and indirect costs incurred from HMNR		
Opinions on roles and responsibilities in conservation and management of HMNR		
Perception of conflict between stakeholders in relation to HMNR		Any signs of conflict between stakeholders will require intervention through mediation. Signs of dissatisfaction in management should be addressed either through awareness raising or through a revised management approach, depending on the situation.

Feeling of local 'ownership' of HMNR		In response to changes in knowledge and understanding of the value and need for mangroves, it is possible that opinions on preferred land use option may also change with time. If support in the community is falling, this indicates the need for a change in communication strategy or the need to reconsider land use options
Perception as to whether the protected area is still valid and justified		

4.4 Indicators to assess practice/use

In the context of HMNR, 'practice and use' is examined in relation to both island inhabitants and visitors to Huraa Island, and is defined as how people make use of the Nature Reserve and the land, water and species contained within it.

The following observations were made in the baseline assessment:

- Extractive use of mangrove and other products is at present very limited;
- Very few tourists and student visit HMNR.

The monitoring plan aims to see whether there are any changes in the ways in which HMNR is used over time, in the levels of use, or in the groups of people who are using it for different purposes. It has a particular focus on extractive resource utilisation activities and on tourist and educational activities, and on whether HMNR is contributing positively to the economic wealth and livelihoods of different sectors of the island community (including shop owners, restaurateurs and the managing authorities).

The nature of stakeholders' practice and use in the protected area can be used by HMNR authorities to better understand the value of mangroves in economic or monetary terms and in terms of income and employment indicators on Huraa Island, in order to make management decisions on how best to maximise both cash revenues and wider economic benefits from the Nature Reserve.

As at present there is very little extraction of mangrove and other products from HMNR and monitoring should focus on non-extractive uses such as recreation, tourism and education (although this does not exclude the monitoring of possible resource harvesting). As the protected area has been recently established, it is to be expected that the area will see a rapid rise in the number of visitors to HMNR over coming months and years, and that the local economy will respond in terms of increased sales of goods and services such as food, handicrafts, guiding and souvenir items.

In order to measure these, the following parameters, associated indicators and methods need to be understood (refer to table 4). Questionnaires designed for data collection (see Annex 1) have carefully incorporated questions to capture these parameters, and a full methodology on how to use the questionnaires is elaborated under section 2.4.

Four indicators related to practice and use have been defined for the monitoring plan, and are outlined in Table 4 below. They are reflected in the socioeconomic data sheets presented in Annex 1 of this document.

Table 4: Suggested indicators related to questions of practice/use

Indicator	Methodology	Why this indicator?
Types and levels of extractive mangrove use taking place	Focus group discussions	Negative changes in this indicator call for serious management interventions of awareness raising and enforcement.
Student numbers visiting HMNR	Secondary data	If demand changes, then facilities and strategies for engaging with tourists and students may have to be changed accordingly.
Tourist numbers visiting HMNR		
HMNR revenues		
HMNR staffing and annual budget		
Types and levels of earnings from HMNR-related activities for different groups shops, restaurants, handicrafts, guides, etc.	Focus group discussions	Signs of increased income indicate that management activities are achieving economic goals. If no increase is shown, the management strategy may need to be revised.
Number of people benefiting from HMNR income		
Relative importance of HMNR-related income in household and village economy		

4.5 Methods for collecting socioeconomic information

Information collection for most of the indicators and parameters described for socioeconomic monitoring utilise the same methodologies (focus group discussions and key informant interviews). They also employ a single survey instrument for each target group (a combined checklist/data sheet) that relates to all three aspects of socioeconomic interactions with HMNR. The exception is the questionnaire which is administered throughout the year to visiting tourists and students. All data sheets and questionnaires are presented in Annex 1 of this report.

In addition to these 'direct' or 'primary' data gathering methods, periodic socioeconomic monitoring should also make efforts to collect information from secondary sources (such as government statistics and reports). Since Huraa Island's community is relatively small, and good data is available for key sectors in the Maldives, relevant secondary information is easily accessible.

1. Secondary data

Secondary sources should be used as far as possible to gather general data. Potential sources for this secondary socioeconomic data are: the HMNR management plan and any potential associated records (e.g. the number of people engaged in protected area related activities; HMNR visitors log book), the Atoll Administration, the Ministry of Tourism (e.g. number of tourist related businesses, tourist revenue), other appropriate ministries and departments and the records of the Island Development Committee. The following information could be collected from secondary data:

- How many tourists have visited HMNR in the last 6 months/1 year?
- Where are they from (list key nationalities)?
- What were the visitation rates before the tsunami?
- How many tourist related businesses are there on Huraa Island?
- What kinds of businesses are they?
- How many employees are there for each business?
- How many students have visited HMNR in the last 6 months/1 year?

- Where are they from (list islands/schools)?
- What was the income to the HMNR management from entrance fees and other profits over the last 6 months/1 year?
- What are the tourists'/students' perceptions on HMNR? (this information could be collected in the visitors log book)

2. Focus group discussions

Focus group discussions are a type of semi structured interview, which involve a selected group of informants (usually groups of 4 to 10 people) who share a common background or knowledge (such as through pursuing a common occupation or livelihood activity, or being members of the same organisation). The flexibility and openness of this data collection method encourages two way interactions, and it is a good way of getting a broad range of information. This method generates primary qualitative information on specific issues.

Initially, it is recommended that three focus group discussions are held during the socioeconomic monitoring (the number of focus groups may change over time, as described below). In each, the selection of individuals should be carried out independently (so as not to only include those people with more power and influence, or those who have a particular wish to express their opinions), but in consultation with the Island Authorities. Efforts should be made to include both women and men, and ideally a gender balance should be achieved in the discussion groups (although if participants are uncomfortable with this, single-gender groups may be conducted simultaneously). The three target groups for focus group discussions are recommended as:



Focus group interviews

(1) A focus group of approximately 8-10 people consisting of shop owners and restaurant managers. These are currently the main businesses that directly benefit from HMNR. However, over time, these groups may change: for example if local community members become involved as guides for tourists and students, this would be an additional group to consider.

(2) A focus group consisting of 8-10 randomly selected people from Huraa Island that would be representative of the diversity of the Island's

inhabitants (male, female, rich, poor, different educational levels and occupations). As noted above, if different socioeconomic or occupational groups are not comfortable participating in a single discussion (or if it transpires that a certain group dominate discussions), then it may be desirable to consider carrying out a number of smaller discussion groups simultaneously.

(3) A focus group consisting of 10-20 young people and schoolchildren. The involvement of the youth in conservation, and their attitudes and knowledge towards HMNR are critical in building a constituency and support for the Nature Reserve in coming years.

During the focus group discussions, a good survey process should observe the following:

- Interview time and place should be agreed with the group in advance
- Start with simple questions
- Allow conflicting opinions to emerge
- Record major points of the discussion
- Requirements are one facilitator, one record keeper and interview guide

3. Key informant interviews

Key informant interviews are carried out individually and are based on a set of open-ended questions or discussion points to generate quantitative information that can be used for monitoring. They are one of the most powerful methods for data collection, as they allow the facilitator a high degree of flexibility to probe for answers, to follow up on the original questions, and to pursue new lines of questions.



Key informant interviews

It is recommended that key informant interviews be carried out with representatives from the following, as these are the main groups who are involved with HMNR management and use:

- (1) Village Chief
- (2) Person responsible for the management of HMNR on the island
- (3) Member of Island Authority office
- (4) Member of Women's Development Committee
- (5) Member of Island Development Committee
- (6) Manager of local resort island (4 Seasons)

During the key informant interviews, a good survey process should observe the following:

- Arrange a place and time for the interview in advance
- Take any extra notes outside the questionnaire structure that may be of interest
- Requirements are one facilitator, one record keeper and one interview guide

4. Questionnaires for students and tourists

It is recommended that questionnaires be administered to all tourist and student groups visiting HMNR. Although filling in the questionnaires should be voluntary, it is hoped that a sufficient number of people will take the time to complete a questionnaire. For student groups, it is suggested that the accompanying teacher be asked to select 3-5 students to complete the questionnaire and to help them fill it in. Similarly, it is suggested that HMNR authorities ask at least 3-5 tourists per month to fill out the tourist questionnaire on their visit to HMNR. These should be analysed on a six monthly or yearly basis (depending on capacity).

5. Ecological monitoring indicators and techniques

The table below provides a summary of the eleven key ecological indicators that will be collected in order to monitor the ecosystem health and conservation issues of HMNR. Each of these indicators and the techniques/parameters that should be used to explore them are elaborated in the sections below. Information collected opportunistically (e.g. any observed mammals/specimens found) should also be recorded, but at minimum, information on these eleven indicators should be collected. Please refer to the publications listed in section 7 of this document for a list of references that will provide more detailed guidance on ecological sampling techniques suggested in this toolkit.

Secondary data

The general weather data (e.g. ambient temperature, wind speed, relative humidity, sunlight etc) during the time of monitoring could be obtained through portable measuring equipment or by referring to existing records. Any recent research or observations should be studied and any available secondary data that relates to the period during which the monitoring is being conducted should be reviewed and referred to in the monitoring results.

Table 5: Overview of ecological monitoring indicators and techniques

Indicator	Technique/Parameter
Indicators to assess ecosystem health	
1. Species composition and abundance of fish	Regular records of commercial/subsistence catches; cast netting
2. Species composition and abundance of birds	Temporal (15 minute) point counts
3. Species composition and abundance of crabs	5L Bucket trap replicate catches
4. Mangrove health and regeneration (in areas subjected to active restoration, as well as in areas undergoing natural regeneration after a disturbance)	Species composition and cover in strip quadrats; Number of saplings in quadrats; Height of saplings
Indicators to assess conservation issues	
5. Dumping of garbage	Area, volume and frequency of dumping
6. Sedimentation	Area and height of sediment deposits
7. Death of mangrove vegetation	Number of trees and area affected
8. Clearing of natural vegetation	Area cleared
9. Reclamation/encroachment (for construction, agriculture)	Area reclaimed/encroached
10. Spread of invasive alien species	Plants: Area of spread and visual impacts Animals: Species abundance and visual impacts
11. Erosion (including destruction of vegetation due to natural causes)	Area subjected to erosion

Informal methods of inquiry

It should be recognised that scientific methods of ecological monitoring should be supported by interviews with individuals or groups within the community who may have knowledge of ecological issues or conservation threats. It is suggested that before physical surveys are carried out, informal conversations with key people in the community are conducted in order to get a picture of changes that may be affecting HMNR, focusing on the period between the last monitoring/baseline survey. Suggested questions include:

- Have there been any obvious changes to the mangrove ecosystem since the last monitoring period (e.g. clearance of mangrove, encroachment)?
- Any noted changes in plant or animal composition/ abundance (e.g. increases/ decreases in the number of certain species)?
- Any records of new animals?
- Are there any waste management issues affecting the mangrove (e.g. dumping of garbage increasing/decreasing)?
- Have there been any other issues observed (e.g. large scale mortality of fish or crabs etc.)?
- Has the area been subjected to an unusual weather event or other event (e.g. tidal surge or storm etc.)?

5.1 Indicators to assess ecosystem health

1. Species composition and abundance of fish

Use of secondary information

The connection between mangroves and fish populations are known to be strong, with mangroves acting as nursing grounds for certain fish species, but the exact relationship between different fish species and the HMNR have not been established. This means that the use of indicator fish species is not possible for HMNR. Even so, fish catch data and analysis collected by the Ministry of Fisheries will provide a useful overview of the health of fish stocks in the area and any abrupt changes in the status of fish populations in the nearby area may be due to impacts that could also affect the HMNR. For this purpose, it is recommended that any available data or analysis of fish populations focusing on Huraa Island and any nearby islands is reviewed as part of the monitoring process.

Direct sampling

Plans to clear the build up of sediment in the lagoon area of the mangrove will potentially result in the re-formation of a lagoon that historically existed in the centre of HMNR. This lagoon may in future become a habitat for fish and other marine species. As well as monitoring levels of sedimentation, the species composition of fish inside this lagoon area will act as an indicator of the lagoon's health. For this reason it is recommended that, once sediment build up is removed, regular monitoring of fish species in the lagoon be carried out.

Methodology

Cast netting techniques should be used to sample fish populations in the lagoon. As cast netting requires a moderate amount of skill, it is suggested that the sampling be carried out either by someone who has prior experience in cast netting, or someone who has been trained to use a cast net for the purpose of this monitoring activity.

The cast net should be thrown randomly in five different locations in the lagoon, casting from the shore of the lagoon, at high tide. Fish caught in the net should be gently removed, identified and subsequently released back into the lagoon. This simple method will provide a rough estimate of the types of species that are present in the lagoon, as well as giving an indication of the relative abundance of different species.

2. Species composition and abundance of birds

In carrying out bird surveys we are trying to establish the species composition and abundance of birds. Any changes in these indicators may be due to changes in the surrounding habitat or other issues such as pollution levels or hunting. In terms of developing ecotourism potential, locating the important areas for bird species of interest would be useful, especially for future management activities such as designing bird watching tours around the HMNR.

Methodology

Bird surveys should be carried out using point counts. This is a simple method that provides a uniform, replicable way of monitoring changes the abundance and species composition of birds over time. The method involves an observer recording the species and number of birds observed in a single location for a set period of time. Observations may be direct (i.e. sightings) or indirect (i.e. through identifying bird calls). It is suggested that 15 minute long point counts be carried out at 4 different locations. The 4 counts should be carried out 3 times a day for 3 consecutive days:

- Repetition 1: between 7-9am
- Repetition 2: between 11am-1pm
- Repetition 3: between 4-6pm

The observer should record (a) all species observed and (b) the number of individuals observed of each species during each point count. A suggested survey sheet format is presented in Annex 2.

3. Species composition and abundance of crabs

Crabs play an important role in recycling in mangrove ecosystems by eating decaying organic matter. Through the physical disturbance created by their burrowing activity they also aerate the soil near mangrove roots, and help bring organic matter up to the surface. They are therefore a good indicator species in mangrove ecosystems, and any change in species composition or abundance may be due to underlying changes in the environment that should be further investigated.

Methodology

Both direct and indirect sampling can be used to monitor crab abundance and species composition. Suggested survey sheet formats are presented in Annex 2.

(a) Direct sampling



Setting bucket traps for crab sampling

After digging small holes in the substrate, bury 5 one litre bucket pitfall traps during the tidal ebb time, each bucket at 2m distance from the other placed randomly, ensuring the bucket mouth is flush with the ground's surface (refer to Figure 2 for guidance on how one set of 5 bucket traps should appear). Check the buckets after 2 hours and document the species and numbers of individuals that are trapped in the buckets. Take digital photos of individuals that can't be identified for identification later on. If absolutely necessary, unidentifiable specimens can be preserved in

formaldehyde in plastic or glass containers. Ideally the sampling should be carried out once in the morning (between 7-9am) and once in late evening (between 6-8pm) over 3 consecutive days. Each day 3 different sets of 5 traps should be set in different locations. This will ensure that after 3 days of sampling, 9 different sites will have been surveyed.

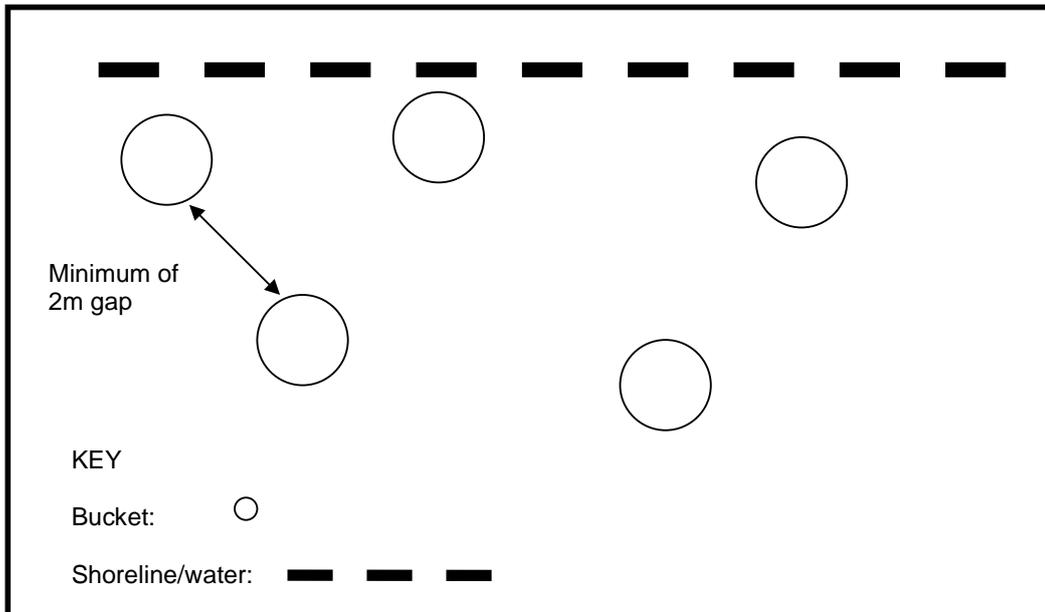


Figure 2: Representation of random placement of bucket traps – this should be repeated in 9 locations in total.

(b) Indirect sampling

During the low tide, place ten 1mx1m quadrats randomly in the high water line area of the mangrove and count the number of crab holes in each quadrat. This will give an estimation of crab activity and their abundance. This should be carried out along the length of the mangrove area to get an idea of distribution across the entire mangrove.



Using indirect sampling methods to assess crab activity and abundance

4. Mangrove health and regeneration

Information on the size of mangrove species, density of mangrove trees, number of damaged trees and the species composition will provide important information on the health and level of regeneration within a mangrove ecosystem, whether it is regenerating naturally after disturbance (such as the case for HMNR after being affected by the 2004 Asian tsunami) or whether it is being actively restored (this will apply to nurseries or areas that are being restored using artificial planting in HMNR).



Measuring out strip quadrats for vegetation sampling

Methodology

Using string and a measuring tape, set out 20mx5m strip quadrats placed parallel to the water body. In each block of mangrove at least 4 replicates should be set out in random locations. In the case of HMNR where there are 4 distinct blocks of mangrove, 16 quadrats will be sampled in total (4 per each block). During future monitoring, sampling is to be repeated in the same strip quadrat. In each quadrat, the following data should be collected:

- No. of trees that have more than 20cm gbh: girth at breast height (i.e. the circumference of the trunk at breast height for an average person exceeds 20cm)
- Species composition and percentage cover
- No. of new seedlings established naturally
- No. of dead trees/fallen trees
- No. of cut trees/stumps

Suggested survey sheet formats are presented in Annex 2.

Note: Only true mangrove species should be surveyed.

Assessing planted seedling growth

To assess the performance of planted seedlings that have been introduced, quadrats can be set up to sample the growth of seedlings in specific areas that are being targeted for assisted recovery. In such instances, an entire plot can be assessed. It is important to set a baseline of the replanted area noting the (a) the area being replanted (georeferenced with GPS) and (b) the number of seedlings that were initially planted. After this, the area can be periodically monitored using indicators:

- Area being replanted (sq.m)
- Number of seedlings surviving
- Height of seedlings (cm)
- No. of leaves/branches (only for first 2 years)
- Digital photographs

5.2 Indicators to assess conservation issues

Please note that data recorded for indicators 5 and 8 should be recorded under the “Mangrove health and regeneration” survey sheet presented in Annex 2.

5. Dumping of garbage

The assessment of garbage dumping should be conducted whilst carrying out the strip quadrat assessments for indicator 4: Mangrove health and regeneration. During this exercise, the levels of garbage dumped in each quadrat should be recorded with regards to:

- Area affected (sq.m)
- Type of garbage (e.g. household waste, industrial waste)
- Digital Photographs

Information should be recorded under the “Mangrove health and regeneration” survey sheet presented in Annex 2.

6. Sedimentation

Sediment build up in HMNR has been identified as a management issue and plans to remove excess sediment are being developed. Subsequent to successful removal of excess sediment, regular monitoring should be carried out to assess any future changes in sediment levels in order to determine whether further management action needs to be taken. Monitoring should be carried out after management actions to reduce sedimentation have been completed.

Methodology

Select five 10mx10m random quadrats in the areas where sediment has been removed, and record:

- (a) The total area per quadrat that contains sediment (sq.m)
- (b) The average depth (cm) of sediment deposition – this should be done by measuring the depth in five random points across the quadrat and calculating the mean depth

7-11 Death of mangrove vegetation; Clearing of natural vegetation; Reclamation/encroachment; Spread of invasive alien species; Erosion

During the monitoring process, ensure that the monitoring team inspects the entire mangrove area for general changes in the ecosystem and indications of conservation issues. In order to investigate potential death of mangrove vegetation, clearing of vegetation or reclamation/encroachment activities that may be taking place, or any sign of alien species spreading.

Methodology

(7) Death of mangrove vegetation

If an area of dead trees is observed, record the following:

- GPS location of affected area
- No. of trees affected
- Area (sq.m) affected
- Species affected
- Any potential causes (e.g. physical damage to trees, chemical substances nearby, signs of disease)
- Digital photographs

(8) Clearing of natural vegetation

Areas of reduced vegetation may be due to deliberate clearance and basic data should be collected to assess the scale of clearance. Assessments should focus on the area within 5m of the boundary around the PA as well as collecting data whilst carrying out the strip quadrat assessments for indicator 4: Mangrove health and regeneration. Information collected from the analysis of strip quadrats should be recorded under the “Mangrove health and regeneration” survey sheet presented in Annex 2. Record the following:

- No. of cut stumps within 5m from boundary around the PA
- No. of cut stumps within the 25mx5m strip quadrats
- GPS location of area
- No. of trees removed
- Area (sq.m) cleared/percentage area affected for strip quadrats
- Digital photographs

(9) Reclamation/encroachment

An area may be reclaimed and/or encroached upon for a particular purpose, such as for construction or domestic use (e.g. storage of boats, building of shelters). If an area shows obvious signs of reclamation or encroachment, record the following:

- GPS location area
- Area (sq.m) reclaimed/encroached upon
- Observed use of area
- Digital photographs

(10) Spread of invasive alien species

Invasive aliens or non-native species, both plant and animal, can threaten the natural functions of native ecosystems and should be monitored carefully. If an invasive alien species is seen to be affecting the mangrove, management action to eradicate it may be necessary. Record the following:

Invasive alien plants

- GPS location of area
- Area of spread (sq.m) and visual impacts (e.g. choking of trees through overgrowth)
- Identify species
- Digital photographs

Animals

- Assess the potential area affected and note on a map
- Estimates of species abundance and visual impacts (e.g. damage to trees, gnawing of trunk/branches)
- Identify species
- Digital photographs (of species if possible and/or of impact on habitat)

(11) Erosion

Erosion is essentially the wearing away or loss of land due to physical action, e.g. due to wave action or storms, and includes destruction of vegetation and soil due to natural causes. If areas of HMNR or the surrounding areas appear to be affected by signs of erosion the following data should be taken:

- GPS location of area
- Area subjected to erosion (sq.m)
- Any observations on potential causes
- Digital photographs

6. Data management, analysis and presentation

The collection of data is only one step in the process of using information collected from the field to influence management. Data storage and analysis must be carried out in a timely manner to ensure that it remains relevant and useful. Furthermore, careful thought must go into the process of disseminating the information generated in the right form and to the right people, so as to ensure that monitoring information will be utilised in the most effective manner. Please refer to the literature listed in the “References” section for additional guidance on data management and analysis techniques.

6.1 Data storage

All original data should be stored in computerised format in an Excel document and should be inputted as soon as possible – ideally within 2 weeks of collecting the data. It is important to ensure that the names of the recorders are also inputted, so that any potential queries about the data can be directed to the correct person.

Image files (i.e. digital photos) should be named in a way that allows easy reference, including a description of what the photo is depicting, the date the photo was taken and a location reference if possible.

Example 1

File name: brug_gym_15apr08_SQ3
Information: *Bruguiera gymnorhiza, 15 April 2008, strip quadrat 3*

Example 2

File name: plntd_seedlings_17apr08_nurs
Information: *planted seedlings, 17 April 2008, nursery*

Once the monitoring report has been finalised, it is suggested that all photos and original data files in excel format are burnt onto a CD, and a copy is kept along with the hardcopy of the report.

6.2 Data analysis and integration

It is recommended that a person with experience in socioeconomic and ecological data analysis should be tasked with processing and analysing the inputted data.

A final report should be generated after each monitoring exercise, which integrates socioeconomic and ecological aspects of the monitoring, describes the status and trends in all the measured indicators, and discusses the potential implications of any changes. A suggested reporting framework is presented in Annex 4.

Changes observed from the baseline (either negative or positive) over the particular time period should be identified and measured. If necessary, comparisons can be made with one period to another period to understand the specific trends of changes. This will help managers to change their management strategies according to the results.

Based on the analysis of the monitoring data, management recommendations should be made. This step should be completed within 3 months of data collection to ensure that the information generated is valid and useful for site level managers.

Sisitka (2002)² provides a useful list of the key stages involved in an analysis and interpretation process:

- Identification of trends and patterns: evaluation requires information about any given situation over time. From this an analysis should reveal what changes may be taking place (increase, decrease or stability in species populations; improved, reduced or maintained quality of life in communities). Such trends may take considerable time to become evident, underscoring the need for consistent and long term monitoring.
- Calculation of the likely outcomes of the trends continuing: this not only enables us to predict what may happen, but also over what period of time, and helps us understand the degree of urgency of any problem being identified. Conversely, where a clear improvement is taking place, this can be valuable in promoting the benefits of a particular aspect of management.
- Identification of factors that may be influencing these trends: it is vital to see what links there may be between the observed trends and what is happening on the mangroves. It is important to avoid jumping to conclusions, or making assumptions about what might be causing a problem with a resource or in a community. There is usually more than one factor involved, and we need to identify all of them and any links between them.
- Identification of the implications (and opportunities) for management: evaluation can help management decide on how to adjust their management: to increase protection of a particular resource; maintain existing levels of protection; or relax them.
- Identification of implications for future monitoring: this can not only be concerned with aspects such as increasing frequency or depth of monitoring according to the levels of threat identified, but can also question the validity of the methods being used, especially if it appears that the information is insufficient or not of high enough quality for meaningful evaluation.
- Reporting and making recommendations: the final stage is the production of evaluation reports including clear recommendations for management. These can then be presented to all key stakeholders.

6.3. Sharing and disseminating information

Once a monitoring report is produced, it is suggested that its contents and findings should be shared with key stakeholders including:

- The institutions or authorities in charge of the management of HMNR
- The Ministry of Environment, Energy and Water
- The community on Huraa Island
- Private sector tour operators and hoteliers bringing visitors to HMNR
- Field recorders that were not involved in the analysis stage

Particular care should be taken to ensure that monitoring information quickly and effectively reaches the individuals who are responsible for management decisions, so as to assist them in devising the best management strategy for HMNR and in ensuring that their management approach is both adaptive and reactive to any changes which are taking place or lessons learned that are generated. Sharing information in a transparent manner to the larger community and associated field recorders encourages ownership and interest in management and monitoring activities.

² Sisitka, L. (2005). Training Module 7: Assessing management effectiveness. In MPA Training Modules, South African MPA Management Training Course. South African Institute of Aquatic Biodiversity and Department of Ichthyology and Fisheries Science, Rodash University <http://www.saiab.ru.ac.za/res/>

There is also a responsibility for researchers to make sure that information collected about individuals and communities are shared with them so that people are aware of how the information that they are providing is being used. In addition to this, any requests for privacy or anonymity should be respected, and the names of respondents should only be included if expressed permission is given. It is suggested that all monitoring reports should be made available to the Huraa Island community via local institutions.

Ideally, the monitoring report should be shared every 1-2 years via a public meeting, which includes all of the groups mentioned above. This means that key stakeholders are all provided with full knowledge of socioeconomic and ecological status and trends pertaining to HMNR, and is also a mechanism for ensuring that both the results of monitoring and the required management responses can be discussed and agreed. At a broader level, this is an important tool in effective and participatory protected area management.

7. Key references

As this toolkit has been developed as a brief and user-friendly guidance for field implementers, much of the background theory and detailed information has been omitted for ease of use. The reference materials suggested below are good background reading that can be used in conjunction with the toolkit. These selected publications provide detailed guidance on different aspects of the monitoring plan and should be used to clarify methodologies and concepts where necessary.

Socioeconomic survey techniques: Even though the following manual was produced for socioeconomic monitoring of communities associated with coral reefs, the tools and techniques are equally valuable in the context of a mangrove ecosystem.

Bunce, L., Townsley, P., Pomeroy, R. & Polinac, R. (2002). Socioeconomic manual for coral reef management. Australian Institute of Marine Science. pp 251

Plant and animal survey techniques: The following provide useful information on how to carry out different sampling techniques.

Stork, N.E. & Nakashizuka, T. (2002). Biodiversity research methods: IBOY in Western Pacific and Asia. Kyoto University Press and Trans Pacific Press. pp 216

Sutherland, W.J. (1996). Ecological census techniques: a handbook. University Press, Cambridge. pp 336.

Sutherland, W.J., Newton, I. & Green, R.E. (2004), Bird ecology and conservation: A handbook of techniques. Oxford University Press. pp 386

Conservation issues and management: The following is an excellent guide on how to use monitoring information gathered practically in effective planning and communication.

Sutherland, W.J. (2000). The conservation handbook: research, management and policy. Blackwell Science Ltd. pp 278

Data analysis: Useful manuals and text books that provide guidance in analysing ecological data.

Bunce, L., Townsley, P., Pomeroy, R. & Polinac, R. (2002). Socioeconomic manual for coral reef management. Australian Institute of Marine Science. pp 251

Fowler, J., Cohen, L. & Jarvis, P. (1998). Practical statistics for field biology. John Wiley & Sons. pp 259

Annex 1 Socioeconomic data sheets

The following data survey sheets are included under this section:

- Secondary data
- Key informant interview (general)
- Key informant interview (HMNR manager)
- Key informant interview (resort island manager)
- Focal group discussion (shop owners/restaurant managers)
- Focal group discussion (random representatives)
- Focal group discussion (young people and school children)
- Questionnaire on knowledge/understanding for students
- Questionnaire on knowledge/understanding for tourists

Secondary data

Informant's name & address:

Enumerator's name:

Number of tourists visiting HMNR and period covered	
Number of students visiting HMNR and period covered	
Revenues from HMNR and period covered	
Budget allocation to HMNR and period covered	
Number of staff in HMNR and period covered	

Key informant interview data sheet (general)

Informant's name & address:
 Date, time and location of interview:
 Enumerator's name:

Knowledge/understanding
Can you list the names of the main mangrove species found on Huraa Island (local names)?
What other plants and animals are found in HMNR?
Can you list the main goods and services provided by the mangroves?
How are mangroves important for human beings?
How are mangroves important to other animals (fish, birds etc)?
Are mangroves important in other ways?
Have you attended any classes, seminars, meetings or workshops on the environment over the last year, and if so what?
Have you interacted with HMNR staff or managers over the last year, and if so how?
Have you heard of the mangrove gene bank, and if so do you know what its purpose is?
Do you feel that you know more about mangroves as compared to a year ago, and if so why?

Attitude/perception
Do you think the mangroves on Huraa Island are in a good state? Explain your statement with examples.
Are the mangroves on Huraa Island threatened, and if so what are the main threats in order of importance?
Is the status of the mangroves improving or declining?
Are the threats increasing or decreasing?
Is it good to manage the mangroves as a protected area, and if so/not how?
What kind of benefits do you and other people get from the conservation of the mangroves?
Does HMNR and mangrove conservation incur any costs to you or others, and if so what?
Who owns HMNR?
Does the island community own HMNR in any way?
Who is responsible for managing HMNR and what are their main responsibilities?
Do you feel responsible at all for HMNR, and if so what is your responsibility or role in conserving mangroves and managing HMNR?
Are you familiar with the management activities and conservation strategies being followed in HMNR, and if so what are these?

Do you think the management arrangements for HMNR need to be improved, and if so how?
Do you see any conflicts arising in relation to HMNR, and if so what are these and who do they involve?
Is it a good thing to protect HMNR, and if so is a Nature Reserve the best way to do this?

Practice/use
Does anyone extract products from HMNR, and if so what and who?
Is the extraction of products from HMNR increasing or decreasing?
Are student visits to HMNR increasing or decreasing?
Are tourist visits to HMNR increasing or decreasing?
What kind of income and economic benefits do local people earn from HMNR?
Are the income and economic benefits earned locally from HMNR increasing or decreasing, and if so which and how (give examples)?
Can you estimate how many people on the island are benefiting from HMNR?
Is the number of people benefiting from HMNR increasing or decreasing?
How important is HMNR to the island economy as compared to other major economic activities (list and prioritise these)?

Key informant interview data sheet (HMNR manager)

Informant's name & address:
 Date, time and location of interview:
 Enumerator's name:

Knowledge/understanding
Can you list the names of the main mangrove species found on Huraa Island (local names)?
Have you facilitated or attended any classes, seminars, meetings or workshops on the environment over the last year, and if so what and with whom?
Have you interacted with the local community or other key stakeholder groups over the last year, and if so how?

Attitude/perception
Do you think the mangroves on Huraa Island are in a good state? Explain your statement with examples.
Are the mangroves on Huraa Island threatened, and if so what are the main threats in order of importance?
Is the status of the mangroves improving or declining?
Are the threats increasing or decreasing?
What is the level of community participation in HMNR management?

Does the island community feel they own HMNR in any way?
What are your main responsibilities in managing HMNR?
Do you think the management arrangements for HMNR need to be improved, and if so how?
Do you see any conflicts arising in relation to HMNR, and if so what are these and who do they involve?
Is it a good thing to protect HMNR, and if so is a Nature Reserve the best way to do this?

Practice/use
Does anyone extract products from HMNR, and if so what and who?
Is the extraction of products from HMNR increasing or decreasing?
Are student visits to HMNR increasing or decreasing?
Are tourist visits to HMNR increasing or decreasing?
What kind of income and economic benefits do local people earn from HMNR?
Are the income and economic benefits earned locally from HMNR increasing or decreasing, and if so which and how (give examples)?

Can you estimate how many people on the island are benefiting from HMNR?
Is the number of people benefiting from HMNR increasing or decreasing?
How important is HMNR to the island economy as compared to other major economic activities (list and prioritise these)?

Key informant interview data sheet (resort island manager)

Informant's name & address:

Date, time and location of interview:

Enumerator's name:

Knowledge/understanding
Do you know that there are mangroves on Huraa Island?
Have you attended any classes, seminars, meetings or workshops on the environment over the last year, and if so what?
Have you interacted with HMNR staff or managers over the last year, and if so how?
Have you heard of the mangrove gene bank, and if so do you know what its purpose is?

Attitude/perception
Are you familiar with the management activities and conservation strategies being followed in HMNR, and if so what are these?
Is HMNR an attractive destination for your clients?
Does HMNR provide good services and visitor experience?
Do you have any views on how tourist experience can be improved in HMNR?
Do you think the management arrangements for HMNR need to be improved, and if so how?

Do you see any conflicts arising in relation to HMNR, and if so what are these and who do they involve?
Is it a good thing to protect HMNR, and if so is a Nature Reserve the best way to do this?

Practice/use
How many tourists from the resort visited HMNR over the last year?
Do you know the tourists main objective of visiting HMNR? (e.g. interesting day trip, bird watching)
Do you think that the establishment of HMNR has improved tourist services?

Focal group discussion data sheet (shop owners /restaurant managers)

Participants' names & addresses:

Date, time and location of interview:

Enumerator's name:

Knowledge/understanding
Can you list the names of the main mangrove species found on Huraa (local names)?
What other plants and animals are found in HMNR?
Can you list the main goods and services provided by the mangroves?
How are mangroves important for human beings?
How are mangroves important for other fish, birds and animals?
Are mangroves important in other ways?
Have you attended any classes, seminars, meetings or workshops on the environment over the last year, and if so what?
Have you interacted with HMNR staff or managers over the last year, and if so how?
Have you heard of the mangrove gene bank, and if so do you know what its purpose is?

Do you feel that you know more about mangroves as compared to a year ago, and if so why?

Attitude/perception

Do you think the mangroves on Huraa Island are in a good state? Explain your statement with examples.

--

Are the mangroves on Huraa Island threatened, and if so what are the main threats in order of importance?

--

Is the status of the mangroves improving or declining?
--

--

Are the threats increasing or decreasing?

--

Is it good to manage the mangroves as a protected area, and if so/not how?
--

--

What kind of benefits do you and other people get from the conservation of the mangroves?

--

Does HMNR and mangrove conservation incur any costs to you or others, and if so what?

--

Who owns HMNR?

--

Does the island community own HMNR in any way?
--

--

Who is responsible for managing HMNR and what are their main responsibilities?
--

--

Do you feel responsible at all for HMNR, and if so what is your responsibility or role in conserving mangroves and managing HMNR?
Are you familiar with the management activities and conservation strategies being followed in HMNR, and if so what are these?
Do you think the management arrangements for HMNR need to be improved, and if so how?
Do you see any conflicts arising in relation to HMNR, and if so what are these and who do they involve?
Is it a good thing to protect HMNR, and if so is a Nature Reserve the best way to do this?

Practice/use
Does anyone extract products from HMNR, and if so what and who?
Is the extraction of products from HMNR increasing or decreasing?
Are student visits to HMNR increasing or decreasing?
Are tourist visits to HMNR increasing or decreasing?
What kind of income and economic benefits do you earn from HMNR?
Are the income and economic benefits you earn from HMNR increasing or decreasing, and if so which and how (give examples)?
How many clients have you had in the last year that had come to the island to visit HMNR?

Can you estimate how many other people on the island are benefiting from HMNR and who are they?
Is the number of people benefiting from HMNR increasing or decreasing?
How important is HMNR to your own income as compared to other major economic activities (list and prioritise these)?
How important is HMNR to your own income to the island economy as compared to other major economic activities (list and prioritise these)?

Focal group discussion data sheet (randomly selected representative members of the community)

Participants' names & addresses:
 Date, time and location of interview:
 Enumerator's name:

Knowledge/understanding
Can you list the names of the main mangrove species found on Huraa Island (local names)?
What other plants and animals are found in HMNR?
Can you list the main goods and services provided by the mangroves?
How are mangroves important for human beings?
How are mangroves important for other fish, birds and animals?
Are mangroves important in other ways?
Have you attended any classes, seminars, meetings or workshops on the environment over the last year, and if so what?
Have you interacted with HMNR staff or managers over the last year, and if so how?
Have you heard of the mangrove gene bank, and if so do you know what its purpose is?

Do you feel that you know more about mangroves as compared to a year ago, and if so why?

Attitude/perception

Do you think the mangroves on Huraa are in a good state? Explain your statement with examples.
--

--

Are the mangroves on Huraa Island threatened, and if so what are the main threats in order of importance?

--

Are the threats increasing or decreasing?

--

Is it good to manage the mangroves as a protected area, and if so/not how?
--

--

What kind of benefits do you and other people get from the conservation of the mangroves?

--

Does HMNR and mangrove conservation incur any costs to you or others, and if so what?

--

Who owns HMNR?

--

Does the island community own HMNR in any way?
--

--

Who is responsible for managing HMNR and what are their main responsibilities?
--

--

Do you feel responsible at all for HMNR, and if so what is your responsibility or role in conserving mangroves and managing HMNR?

--

Are you familiar with the management activities and conservation strategies being followed in HMNR, and if so what are these?

--

Do you think the management arrangements for HMNR need to be improved, and if so how?
Do you see any conflicts arising in relation to HMNR, and if so what are these and who do they involve?
Is it a good thing to protect HMNR, and if so is a Nature Reserve the best way to do this?

Practice/use
Does anyone extract products from HMNR, and if so what and who?
Is the extraction of products from HMNR increasing or decreasing?
Are student visits to HMNR increasing or decreasing?
Are tourist visits to HMNR increasing or decreasing?
What kind of income and economic benefits do local people earn from HMNR?
Are the income and economic benefits earned locally from HMNR increasing or decreasing, and if so which and how (give examples)?
Can you estimate how many people on the island are benefiting from HMNR?
Is the number of people benefiting from HMNR increasing or decreasing?
How important is HMNR to the island economy as compared to other major economic activities (list and prioritise these)?

Focal group discussion data sheet (young people and school children)

Participants' names & addresses:

Date, time and location of interview:

Enumerator's name:

Knowledge/understanding
Can you list the names of the main mangrove species found on Huraa Island (local names)?
What other plants and animals are found in HMNR?
How are mangroves important for human beings?
How are mangroves important for other fish, birds and animals?
Are mangroves important in other ways?
Do you study the environment and mangroves at school, if so what topics do you cover?
Have you interacted with HMNR staff or managers over the last year, and if so how?
Have you heard of the mangrove gene bank, and if so do you know what its purpose is?
Do you feel that you know more about mangroves as compared to a year ago, and if so why?

Attitude/perception
Do you think the mangroves on Huraa Island are in a good state? Explain your statement with examples.
Are the mangroves on Huraa Island threatened, and if so what are the main threats in order of importance?
Is the status of the mangroves improving or declining?
Are the threats increasing or decreasing?
Is it good to manage the mangroves as a protected area, and if so/not how?
What kind of benefits do you and other people get from the conservation of the mangroves?
Does HMNR and mangrove conservation incur any costs to you or others, and if so what?
Who owns HMNR?
Does the island community own HMNR in any way?
Who is responsible for managing HMNR and what are their main responsibilities?
Do you feel responsible at all for HMNR, and if so what is your responsibility or role in conserving mangroves and managing HMNR?
Are you familiar with the management activities and conservation strategies being followed in HMNR, and if so what are these?

Do you think the management arrangements for HMNR need to be improved, and if so how?
Do you see any conflicts arising in relation to HMNR, and if so what are these and who do they involve?
Is it a good thing to protect HMNR, and if so is a Nature Reserve the best way to do this?

Practice/use
Does anyone extract products from HMNR, and if so what and who?
Is the extraction of products from HMNR increasing or decreasing?
Are student visits to HMNR increasing or decreasing?
Are tourist visits to HMNR increasing or decreasing?
What kind of income and economic benefits do local people earn from HMNR?
Are the income and economic benefits earned locally from HMNR increasing or decreasing, and if so which and how (give examples)?
Can you estimate how many people on the island are benefiting from HMNR?
Is the number of people benefiting from HMNR increasing or decreasing?
How important is HMNR to the island economy as compared to other major economic activities (list and prioritise these)?

Questionnaire on knowledge/understanding for students

Student's name & school:

Date, time and location of interview:

Teacher's name:

Number of people on this school visit:

Is this your first visit to HMNR?
Have you ever been on any other environmental trips to other places, if so where and when?
How long did you spend on your visit to HMNR?
Where did you go, and what did you do while visiting HMNR?
Do you study the environment at school?
Are you interested in the environment, if so why?
Did you know anything about mangroves before you came to HMNR?
Can you name 5 things you have learned about mangroves and the environment during your visit to HMNR?
Can you name a mangrove species (local name)?
Can you name an animal that depends on the mangroves here?
Why do you think mangroves are useful to people?

Why do you think mangroves are important to other animals (fish, birds etc?)
What are the main threats to mangroves in the Maldives?

Questionnaire on knowledge/understanding for tourists

Name:
 Resort:
 Country of origin:
 Date, time and location of interview:
 Number of people on this tourist visit:

Why did you come to HMNR?
How long did you spend on your visit to HMNR?
Where did you go, and what did you do while visiting HMNR?
Did you know anything about mangroves before you came to HMNR?
Can you name 5 things you have learned about mangroves and the environment during your visit to HMNR?
How would you rate the level of experience at HMNR, and how could this be improved?
How would you rate the level of service at HMNR, and how could this be improved?
What improvements would you suggest to improve the reserve?
Would you recommend the reserve to others?

Annex 2 Ecological data sheets

The following data survey sheets are included under this section:

- Huraa Island bird survey
- Huraa Island crab direct observation survey
- Huraa Island crab indirect observation survey
- Huraa Island mangrove health and regeneration survey

Huraa Island Bird Survey Data Sheet

Name/s of data recorders:

Date:.....**Time:**.....

Method of sampling: 15 minute point radial counts

Species	No. of individuals/Remarks
Sample 1, GPS Coordinates/location:	
Sample 2, GPS Coordinates/location:	
Sample 3, GPS Coordinates/location:	
Sample 4, GPS Coordinates/location:	

Huraa Island Crab Direct Observation Survey Data Sheet

Name/s of data recorders:

Date:.....

Method of sampling: bucket pitfall traps

Species	No. of individuals/Remarks
Sample 1, GPS Coordinates/location:	
Morning sample, Time:.....	
Evening sample, Time:.....	
Sample 2, GPS Coordinates/location:	
Morning sample, Time:.....	
Evening sample, Time:.....	
Sample 3, GPS Coordinates/location:	
Morning sample, Time:.....	
Evening sample, Time:.....	

Huraa Island Crab Indirect Observation Survey Data Sheet

Name/s of data recorders:

Date:..... **Time:**.....

Method of sampling: bucket pitfall traps

Quadrat number and GPS Coordinates/location	No. of holes per quadrat
Q1	
Q2	
Q3	
Q4	
Q5	
Q6	
Q7	
Q8	
Q9	
Q10	

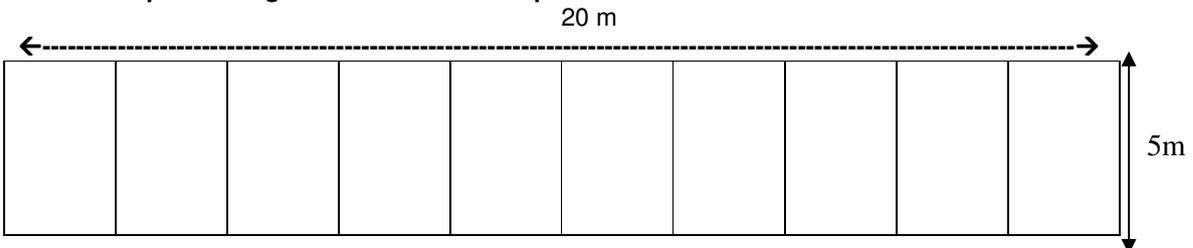
Huraa Island Mangrove Health and Regeneration Survey Data Sheet

Mangrove block number:.....

Date:

Strip Quadrat No:.....**Size:** 20 x 5 m **GPS Coordinates:**.....

Sketch of quadrat alignment and cover of species:



Species	Estimated percentage cover

No. of trees > 20cm gbh	
No. of new seedlings established naturally	
No. of dead trees/fallen trees	
No. of cut trees/stumps	

Garbage	
Total area affected (sq. m)	
Type of garbage	

Annex 3 Summary of the HMNR baseline data

Socioeconomic and ecological data gathered during the baseline survey carried out by IUCN in May 2007 were reviewed jointly to give an overall picture of the status of HMNR and to identify the key issues for management action and monitoring. There were a number of clear findings from the baseline assessment that are elaborated below. Please refer to the full baseline report for more detailed information – this can be found in the ERC library.

Conservation issues

There were a number of observed issues that are likely to affect the future management and conservation of the mangroves, and that will negatively impact mangrove health:

- Sedimentation has severely affected the mangrove ecosystem and is threatening the survival and future regeneration of mangrove plants
- The dumping of garbage in the mangroves may affect mangrove health and storage of garbage near the mangroves may decrease the scenic value of the area
- There is some sign of encroachment into HMNR – e.g. the location of a boat repair operation in the mangrove area
- Certain areas of mangrove associate vegetation that is of conservation interest is currently not protected under the HMNR

Economic value and use of mangroves

In terms of the current economic value of HMNR to the local community, it was clear that:

- The mangrove is not currently generating any direct economic benefits to the local community
- Very few tourists and students visit the mangrove
- Physical mangrove extraction is at present very limited and thus not a conservation issue or a source of economic revenue

Levels of knowledge and perceptions of HMNR

The baseline assessment gave a clear picture of (a) local levels of knowledge of mangroves and (b) people's perceptions of HMNR:

- It was clear that people living on Huraa Island had a good knowledge and understanding of the goods and services being provided by the mangrove
- However, what is not clear is the knowledge and understanding of students and tourists
- People from Huraa Island knew the mangrove was declared a protected area, but were not clear about who owns and manages it
- Developing the mangrove area for tourism and education purposes was a popular land use option favoured by the local community

Annex 4 Draft framework for monitoring report

The following is a suggested outline that may be used to synthesise results and report back on findings. Examples of how findings should be presented are given in each section and these should be used as guidance to frame the results from monitoring. **Please note that these are examples only and are not factually correct.**

A. INTRODUCTION

Provide a brief introduction to the monitoring report providing the following information:

- The period that the monitoring reports covers.
- Date of the last monitoring report
- Names of all those involved in the monitoring
- Any major issues or problems (*e.g. unable to carry out focal group discussions as individuals were not available; bad weather did not allow for the collection of good bird data*).
- Whether any unusual circumstances or events have occurred (*e.g. natural events such as major storms, political events such as elections, new laws or policies, key local events, etc*) and how they have affected the local context.

B. REPORTING ON SOCIOECONOMIC INDICATORS

For all of the indicators below, provide an overview of the findings from the socioeconomic survey carried out during the monitoring period. Note the following:

- Overall findings for each indicator
- General trends in each indicator with regard to observations from the previous phase of monitoring
- Observations on differences between different focal groups
- Any other observations

Indicator	Overview of findings
Indicators to assess knowledge and understanding	
Knowledge of local names of mangrove and related species and scientific names of mangroves and related species.	<i>e.g. very few people know these names, although knowledge is much better among local women. However, knowledge has risen substantially since the last monitoring report, especially among schoolchildren. An educational field day was held for the local school in HMNR over the reporting period.</i>
Understanding of provisioning, supporting, regulating and cultural services provided by mangroves.	<i>e.g most people seem to have a good understanding of the role of mangroves in shoreline defence, but are less aware of the fact that mangroves are important to fisheries. It was found that schoolchildren had the best overall understanding of the services provided by mangroves, whilst those involved in the restaurant industry had the least knowledge.</i>
Attendance of meetings, classes, seminars and other interactions on conservation and mangroves.	

Knowledge of the existence and purpose of the gene bank.	
Indicators to assess attitude and perception	
Perception of mangrove condition, basis for those perceptions.	<i>e.g. most people feel that mangrove status is improving, and cite their observations of more greenery and less dumping of rubbish as the reason. It is interesting to note that fishermen state that they believe that mangrove condition has improved because they are catching more fish close to HMNR.</i>
Perception of the nature and level of current threats to the mangroves.	
Positive or negative attitude to the existence of the protected area and the way in which it is managed.	
Perceptions of the types of material and indirect benefits gained from HMNR.	
Perceptions of the types of material and indirect costs incurred from HMNR.	
Opinions on roles and responsibilities in conservation and management of HMNR.	<i>e.g. most people seemed to think that ERC was solely responsible for implementing management activities and did not understand the role of the Island level authorities.</i>
Perception of conflict between stakeholders in relation to HMNR.	
Feeling of local 'ownership' of HMNR.	
Perception as to whether the protected area is still valid and justified.	
Indicators to assess practice and use	
Types and levels of extractive mangrove use taking place.	<i>e.g. all groups stated that they do not think any mangrove extraction is occurring, except for women, who stated that firewood is still being harvested on a small-scale. This is a major difference from the last monitoring report, where most people felt that some extractive uses were still being carried out.</i>
Student numbers visiting HMNR.	

Tourist numbers visiting HMNR.	
HMNR revenues.	
HMNR staffing and annual budget.	
Types and levels of earnings from HMNR-related activities for different groups shops, restaurants, handicrafts, guides, etc.	
Number of people benefiting from HMNR income.	
Relative importance of HMNR-related income in household and village economy.	
General discussion and management recommendations	

C. REPORTING ON ECOLOGICAL INDICATORS

For all of the indicators below, provide an overview of the findings from the ecological surveys carried out during the monitoring period. Note the following:

- Overall findings for each indicator
- General trends in each indicator with regard to observations from the previous phase of monitoring
- Any other observations

1. Species composition and abundance of fish

Review of existing, relevant fisheries data from the Ministry of Fisheries.	<i>e.g. general status of surrounding fish stocks; local catch and landing reports; analyses/reports noting changes in catch number/species diversity.</i>
Summary of cast netting survey results.	<i>Provide the names of species caught and notes on any observations on perceived abundance.</i>
Narrative describing changes since the last monitoring.	<i>e.g. changes in species composition/abundance and any other observations.</i>
Management recommendations (if any).	

2. Species composition and abundance of birds

Summary of point count survey results.	<i>Provide the names of all species observed and notes on any observations on perceived abundance.</i>
Narrative describing changes since the last monitoring.	<i>e.g. changes in species composition/abundance and any other observations.</i>
Management recommendations (if any).	

3. Species composition and abundance of crabs

Summary of direct sampling survey results.	<i>Provide the names of all species observed and notes on any observations on perceived abundance.</i>
Summary of in direct sampling survey results.	<i>Provide the names of species observed and notes on any observations on perceived abundance.</i>
Narrative describing changes since the last monitoring.	<i>e.g. changes in species composition/abundance and any other observations.</i>
Management recommendations (if any).	

4. Mangrove health and regeneration (in areas subjected to active restoration, as well as in areas undergoing natural regeneration after a natural disaster)

Provide a description of any management activities that have taken place since the last monitoring session (e.g. mangrove planting).	<i>e.g. 2 hectares of mangroves have been replanted around the lagoon, and a nursery established.</i>
Quantification of health and regeneration:	
Mean number (and variance) of trees that have more than 20cm gbh: girth at breast height (i.e. the circumference of the trunk at breast height for an average person exceeds 20cm).	<i>Provide the mean value and variance from the data gathered from all the quadrats surveyed.</i>
Summary of species composition and percentage cover.	<i>Give a summary of the main species found, general abundance and any geographical variations.</i>
Mean (and variance) number of new seedlings established naturally.	
Mean (and variance) number of dead trees/fallen trees.	
Mean (and variance) number of cut trees/stumps.	

Narrative describing any changes since the last monitoring.	<i>e.g. any increase/decrease in mangrove health, any difference noted between the different areas of HMNR) and any other observations.</i>
Management recommendations (if any).	

5. Dumping of garbage

Provide a description of any management activities that have taken place since the last monitoring session.	<i>e.g. there is now a garbage collection site in the main village; there has been stricter enforcement of anti-dumping laws (number of fines given etc).</i>
Quantification of garbage dumping: mean number (and variance) of piles found).	<i>Provide the mean value and variance from the data gathered from all the quadrats surveyed. Describe any notable patterns (e.g. greater amounts of garbage in certain quadrats compared to others).</i>
Narrative describing changes since the last monitoring.	<i>e.g. if there has been a significant change in garbage dumping, which areas of the reserve are most affected and any other observations.</i>
Management recommendations (if any).	

6. Sedimentation

Provide a description of any management activities that have taken place since the last monitoring session.	<i>e.g. any dredging activities to remove sediment? When and how much sediment was removed?</i>
Mean (and variance) depth of bay this monitoring period.	
Narrative describing changes since the last monitoring.	<i>e.g. if there has been a significant change in depth/sediment deposition and any other observations.</i>
Management recommendations (if any).	

7. Death of mangrove vegetation

Quantification of dead trees observed.	<i>Provide the mean value and variance from the data gathered from all the quadrats surveyed.</i>
Narrative describing changes since the last monitoring.	<i>e.g. if there has been a significant change in tree death and any other observations.</i>
Management recommendations (if any).	

8. Clearing of natural vegetation

Quantification of clearance of vegetation (mean and variance number of cut stumps/tress removed/area cleared).	<i>Provide the mean value and variance from the data gathered from all the quadrats surveyed. Describe any notable patterns (e.g. greater amounts of clearance in certain quadrats compared to others).</i>
Narrative describing changes since the last monitoring.	<i>e.g. if there has been a significant increase/decrease in vegetation clearance, which areas of the reserve are most affected, and any other observations.</i>
Management recommendations (if any).	

9. Reclamation/encroachment (for construction, agriculture)

Narrative describing changes since the last monitoring.	<i>e.g. has there been a significant increase/decrease in reclamation/encroachment, which areas of the reserve are most affected and any other observations.</i>
Management recommendations (if any).	

10. Spread of invasive alien species

Narrative describing changes since the last monitoring.	<i>e.g. if there has been a significant increase/decrease in the prevalence of invasive alien species, which species are of most concern, which areas of the reserve are most affected, and any other observations.</i>
Management recommendations (if any).	

11. Erosion (including destruction of vegetation due to natural causes)

Narrative describing changes since the last monitoring.	<i>e.g. new areas experiencing erosion, which areas of the reserve are most affected, and any other observations.</i>
Management recommendations (if any).	

D: SYNTHESIS OF SOCIOECONOMIC AND ECOLOGICAL FINDINGS

Are there any major areas where socioeconomic and ecological indicators seem to support each other?	<ul style="list-style-type: none"> <i>e.g. the village focus groups note that garbage dumping has decreased substantially. Ecological monitoring also shows that the amount of garbage in HMNR has decreased.</i> <i>e.g. key informant interviews noted that there has been greater clearance of mangrove on the outer edges of the park. Ecological monitoring also recorded more cut stumps and cleared areas in the same locations.</i>
Are there any major areas where socioeconomic and ecological indicators seem to contradict each other?	<ul style="list-style-type: none"> <i>e.g. although the ecological monitoring shows a lower bird count, local schoolchildren say that there are many more birds to be seen in HMNR.</i> <i>e.g. the majority of people interviewed in focus group discussions felt that less garbage is now being dumped in HMNR. Ecological monitoring found that more garbage was now being dumped in the interior parts of HMNR.</i>

E: SUMMARY AND MANAGEMENT IMPLICATIONS

Summarise the key conclusions emerging from the monitoring and provide a synthesised list of management recommendations. Also make any suggestions for changes in the monitoring protocol based on findings and perceived needs in response to changes.

Main conclusions	Management implications	Recommended changes in monitoring protocol/interventions
<p><i>e.g. there are many more tourists coming to HMNR, and it has been noted that they are throwing away empty water bottles and other rubbish in the protected area.</i></p>	<ul style="list-style-type: none"> • <i>Tourism is presenting a threat to HMNR through garbage disposal. Rubbish bins should be placed at key points in HMNR, and notices put up about disposing of rubbish properly.</i> • ... 	<ul style="list-style-type: none"> • <i>Monitor garbage dumping by tourists at key sites which are visited in HMNR.</i> • ...
<p><i>e.g. many local people continue to feel negatively towards HMNR because they do not think they benefit from it.</i></p>	<ul style="list-style-type: none"> • <i>There is a need to incorporate more local benefit-sharing and income-generating activities into the HMNR management plan.</i> • ... 	<ul style="list-style-type: none"> • <i>More in-depth monitoring is required of the community's perceptions of benefits gained from HMNR. In particular, monitoring should track the perceived changes arising from new benefit-sharing and income-generating activities to be initiated.</i> • ...
<p><i>e.g. 15% of mangrove trees (mixed species) in the western block of the Reserve were observed as showing signs of disease and 5% appeared to be dying.</i></p>	<ul style="list-style-type: none"> • <i>There is a need to investigate the causes of this and ensure that the die back is stopped.</i> • ... 	<ul style="list-style-type: none"> • <i>A targeted investigation is needed. A botanist with expertise in plant disease and mangroves should be contracted to review the possible causes of disease.</i> • <i>Potential causes should be monitored in response to findings (e.g. if increased pollution is found to be the cause, this needs to be monitored).</i> • ...

